CHAPTER 1

INTRODUCTION

1.1 Introduction and Background

In the last three decades, experimental study correlating the soil particle breakage and its liquefaction resistance has attracted many researchers. This is due to the liquefaction case histories which make this phenomenon as one of the most interesting, controversial and complicated one. In Nepal, for instance, the history of earthquakes there started as early as 1934 and continued till 2015. However, there were no liquefaction history recorded except for the year 2015, where several liquefaction surface manifestations were depicted across Kathmandu Valley (Gautam, de Magistris, & Fabbrocino, 2017). Narrowing down to liquefaction histories near to our research area which is located in Southeast Asia, countries like Indonesia has also encountered this phenomenon. Liquefaction occurred during the earthquake in Padang, Indonesia on 2009 which collapsed few buildings, damaged water facilities and also roadways (Hakam, 2012).

Even in Malaysia, particularly in East Malaysia, earthquakes were reported at Ranau and Kundasang, Sabah in June 2015 where Institution of Engineers Malaysia (IEM) has listed liquefaction as one of the post-earthquake potential hazards (Lim, 2015). Although Ranau has experienced earthquake since year 1897 (Sooria, Sawada, & Goto, 2012), no liquefaction histories has ever been recorded except for year 2015 where a warning has been announced. The history of earthquake occurrence frequency in Malaysia is another factor that draws to the study of liquefaction potential in Malaysia.

Liquefaction is a phenomenon where saturated soil loses its strength and stiffness as a response to an applied stress, usually caused by earthquake shaking or other

conditions, causing the soil to behave like a liquid (Forootan, Silakhori, & Alvandi, 2015). Although the damages that can be caused by earthquakes are more severe, liquefaction can cause significant damages to underground pipelines, airports, harbour facilities, and roads or highway surfaces (Animaton, Tan & Fauziah, 2013). As sand soil easily liquefies compared to other soil types (Liu, Orense, & Pender, 2015), sand soil has been chosen to be tested in this research. Sandy soil is vastly used in construction industry such as in buildings, roadways, dams, embankments and many more. However, soil particle breakage occurs when the soil grains are exposed to high stresses during activities like pile driving, high earth and rock fill dams' construction, impact of projectile, and petroleum extraction (Bartake & Singh, 2007). Such breakage alters the existing characteristics of the soil, which makes the soil to lose its strength. Therefore, re-evaluation of soil behaviour after breakage of particles is essential for the design and construction of structures. Such research is prudent to assist engineers to produce a seismically resistant structures in locations susceptible to liquefaction.

1.2 Problem Statement

Liquefaction is more likely to occur in loose saturated granular soil. Such condition can be spotted along the coastal areas where the soil will be granular and saturated with water. Granular soil tends to break when they are subjected to high stresses due to activities such as compressing impact during installation of foundation like pile driving into the ground. Such activity leaves a crushing impact to the soil which eventually modifies the existing soil characteristic due to the breaking down of the soil particles. Thus, it is essential to identify the change in the soil characteristics after the crushing impact in order to know how significant is the changes so that the engineers can consider whether this criterion should be considered in designing a foundation.

There are few characteristics of soil that could be affected due to particle crushing such as grain size distribution, permeability of soil, angularity and mineral hardness. Methods to analyze some of these factors are complicated and the accuracy of the study is questionable. Thus, in choosing a factor to study about the soil characteristics, aspects like reliability and accuracy need to be considered.

Particle Size Distribution can be used as a method to study the effects of crushing impact on grain size distribution. It is a basic method that has been used in previous studies to study grain size distribution of soil. Generation of particle size distribution curve is simple and comparison with other type of soil can be done easily as each type of soil has its own range in particle size distribution curve.

1.3 Research Question

To achieve its research aim, the study targets to address the following research questions:

1) Do the engineering properties of the sand soil samples vary before and after crushing?
2) Does the grain size distribution parameters changes before and after crushing?
3) What is the relationship between the crushing impact and liquefaction of sand soil in Kuantan?

1.4 Research Objective

The main purpose of this research is to analyse the relationship between the crushing impact and the liquefaction potential of sand soil from different locations along the coastal area of East Coast Peninsular Malaysia (Kuantan area). Three specific objectives have been listed in order to achieve this research aim.

Objective 1: To determine the engineering properties of the sand soil samples from all locations before and after crushing.

Objective 2: To analyse the grain size distribution parameters of samples before and after crushing.

Objective 3: To identify the liquefaction potential of the samples by using Particle Size Distribution curve for various crushing impact.